Space Weather Technical Forecast

Issued on Friday, 29 October 2021 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G3/Strong Geomagentic Storms on 30th/31st. Moderate or Low Solar Activity with a slight chance of further X-flares/R3 Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity is High, with two M-flares from AR2887 (Dai/Beta-gamma-delta) in the last 24 hours, M1.4 at 28/0740 UTC and M2.2 at 28/1028 UTC. This was then followed by an X1.0 flare at 28/1535 UTC from the same sunspot region. This is a moderately sized complex and evolving region in the southern central disc. AR2891 (Dki/Beta-gamma) in the northeast has remained fairly inactive in the last 24 hours, despite its history of M-flaring, though recent coronagraph imagery suggests an increase in magnetic looping and flux. AR2889 Axx/Alpha in the southeast and AR2890 Bxo/Beta in the southwest have continued to gradually decay, whilst AR2886 Hsx/alpha has persisted as an inactive and mature feature. The X-class flare from AR2887 resulted in a large full-halo Earth-directed CME. This feature has been analysed and expected to arrive at Earth later in the UTC day on the 30th.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR at L1 was at background levels, declining from 330 km/s to around 300 km/s. The density was initially at average levels, but has increased to mainly above average levels since 28/1245 UTC with a peak of nearly 17 ppcc at 28/2152 UTC. The strength of the interplanetary magnetic field (IMF), Bt, was weak throughout and below 6nT with the north-south component, Bz, ranging between +4 nT and -3 nT. The phi angle was almost exclusively in the negative sector (towards the Sun). Geomagnetic activity was Quiet throughout, Kp 0-1.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured by GOES-16 was at background levels until after the X-class flare. An S1 (Minor) radiation storm was observed from 28/1740 UTC and remained above this threshold to the end of the UTC day. A peak of 23 ppcm was recorded at 28/2335 UTC. High energy electron flux (greater than 2 MeV) was predominantly at background levels with the associated 24-hour electron fluence below the Active (1e8 integrated pfu) threshold with 3.07e6 integrated pfu recorded at 29/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is forecast is forecast to be Moderate to Low with a chance of further M-class flares and slight chance of X-class flares, primarily from AR2887 or AR2891.

Solar Wind / Geomagnetic Activity: A large CME from an X-class flare eruption on the 28th has been analysed and is forecast to arrive at Earth later on Day 2 (30th). A glancing impact from a passing CME is also possible late Day 2 or early Day 3. This originated from a filament eruption around 26/2000 UTC, but is low confidence. No other CMEs are currently expected to arrive at Earth. There are no coronal holes of interest for the forecast period on the visible disc, with no notable fast wind enhancements expected aside from the predicted CME arrival.

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Geomagnetic activity is forecast to be mainly Quiet on Day 1 and early Day 2, with a slight chance of Unsettled intervals. From later Day 2 Minor Geomagnetic storms (G1/G2) are expected, with a chance of G3/Strong Storms. Geomagnetic activity is then expected to subside during Day 3 and Day 4 (1st November) with an eventual return to mainly Unsettled levels, with a chance of Active intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux will start Day 1 (29th) above the S1/Minor storm level. In the absence of any further significant flares the high energy proton flux is expected to return to background levels during Day 1, but with a continued slight chance of reaching the S1 level again with any notable flares from the significant sunspot regions on the Earth-facing disc. The high energy electron flux (greater than 2 MeV) is forecast to remain mostly at background levels between Days 1 and 3 (29th-31st), but with a risk of exceeding the Active level (1e3pfu) threshold by Day 4 as Geomagnetic activity following the expected CME arrival subsides. From a low start with the associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) level, but with a chance of exceeding this threshold on Day 4 (1st November).

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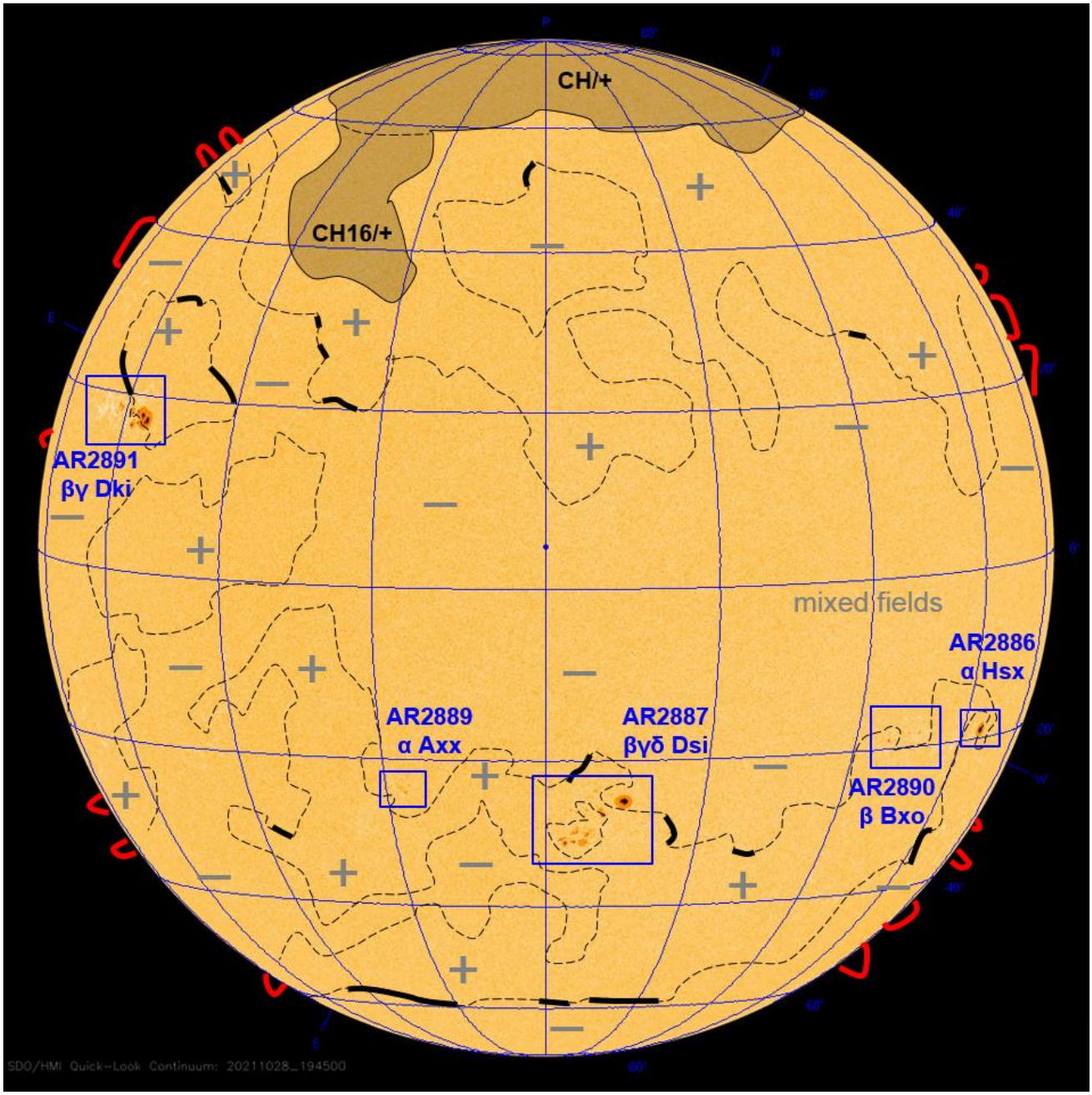
Figure 1. Solar Analysis Valid 28/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A large full-halo CME was observed leaving the sun in coronagraph imagery following the X-class flare from AR2887 on the 28th. This feature has been analysed, is Earth-directed and expected to arrive later in the UTC day (around 1500 UTC) on Day 2 (30th).

A filament eruption that occurred on the 26/2000 UTC has the potential to give glancing effects on passing behind the Earth, most likely late on the Day 2 or early Day 3 (31st). A further filament eruption occurred in the vicinity of AR2887 around 27/2300 UTC, but no visible CME in available imagery has as yet been identified. No further Earth-directed CMEs have been observed to those described.

Solar winds are currently at background levels. There are no coronal holes of interest for the forecast period on the visible disc, with no notable fast wind enhancements expected aside from the predicted CME arrival. Geomagnetic activity is forecast to be mainly Quiet on Day 1 and early Day 2, with a slight chance of Unsettled intervals. From later Day 2 Minor Geomagnetic storms (G1/G2) are expected, with a chance of G3/Strong Storms. Geomagnetic activity is then expected to subside during Day 3 and Day 4 (1st November) with an eventual return to mainly Unsettled levels, with a chance of Active intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	80	40	10
Strong	G3	No	1	40	10	1
Severe	G4	No	1	10	3	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/1844	Full-halo	AR2887	Centre disc, S Hemisphere	1200 km/s	30/1500 UTC	

Figure 2: ENLIL showing CME impact at Earth on 30th around 1500 UTC.

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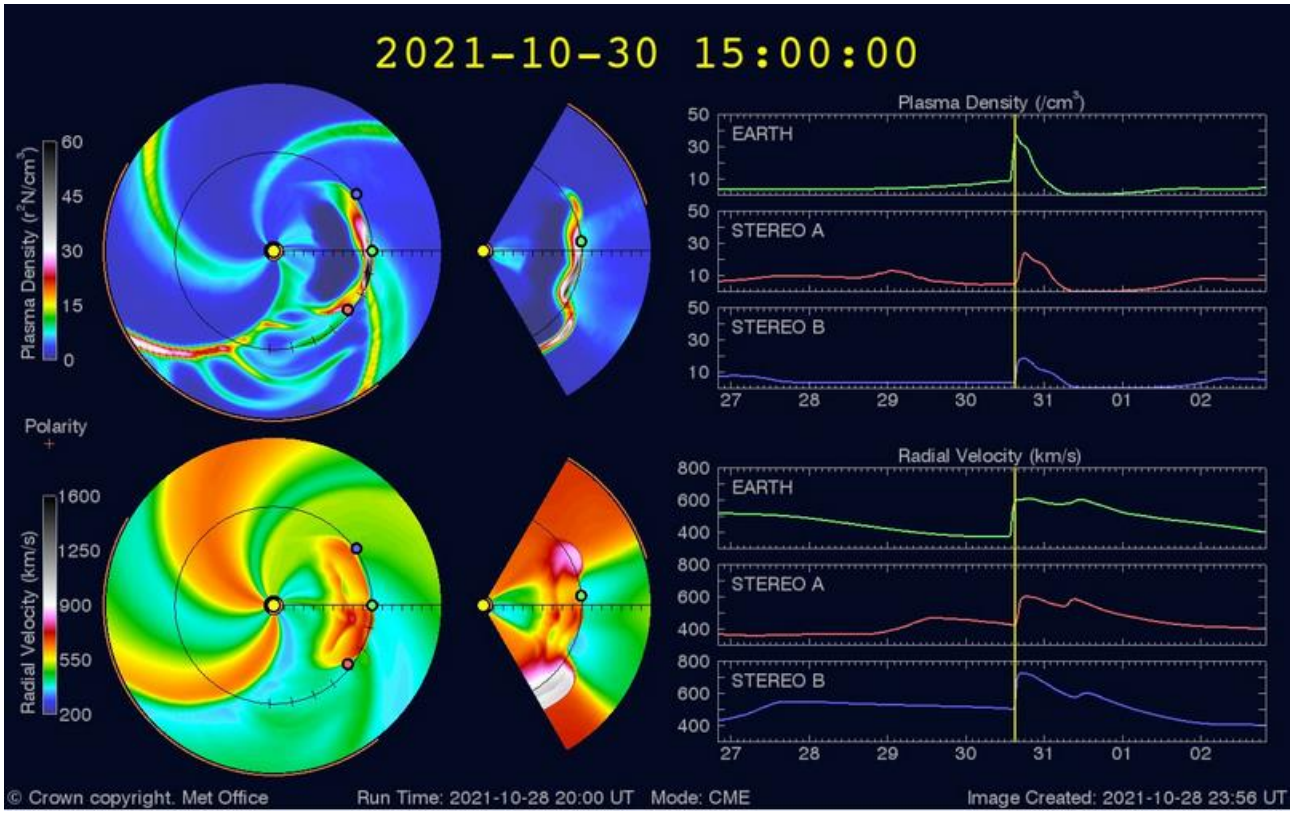

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Radio Blackouts - X-Ray Flares:

Solar Activity is currently High, with two M-flares from AR2887 (Dai/Beta-gamma-delta) in the last 24 hours, M1.4 at 28/0740 UTC and M2.2 at 28/1028 UTC. This was then followed by an X1.0 flare at 28/1535 UTC from the same sunspot region. This is a moderately sized complex and evolving region in the southern central disc.

AR2891 Dki/Beta-gamma in the northeast has remained fairly inactive in the last 24 hours, despite its history of M-flaring, though recent coronagraph imagery suggests an increase in magnetic looping and flux and holds the potential for significant flares.

AR2889 Axx/Alpha in the southeast and AR2890 Bxo/Beta in the southwest have continued to gradually decay, whilst AR2886 Hsx/alpha has persisted as an inactive and mature feature.

STEREO-A EUVI 195 imagery suggests there are two or three bright flux regions that are expected to rotate onto the Earth-facing disc in the next four days.

Activity is expected to be at Moderate to Low levels mainly, with a chance of further M-flares and a slight chance of X-class flares, most likely from AR2887 or AR2891.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	40	40
Very Active	R3 to R5 X Class	Yes	10	10	5	5

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at S1/Minor storm levels. In the absence of any further significant flares the high energy proton flux is expected to return to background levels during Day 1, but with a continued slight chance of reaching the S1 level again with any notable flares from the significant sunspot regions on the Earth-facing disc (AR2887 or AR2891). The slight increase in probabilities of S1/Minor storms on Day 4 is as AR2887 moves into a more favourable location on the sun.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	100	20	10	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO is currently at background levels and expected to remain at this or moderate levels for much of the period. The expected arrival of the large CME on the 30th may act to initially suppress the Van Allen radiation belts before likely returning towards a prevailing state at the end of the forecast period. This means that an increase in electron flux is expected on Day 3 (31st) and Day 4 (1st November), with a chance of reaching the Active electron (1e8 integrated pfu) fluence threshold on Day 4. REFM is expected to give good guidance until the 30th with the anticipated arrival of the large CME at Earth.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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